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AGRICULTURAL EXPERIMENT STATION
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This project was supported in part by cooperative funds furnished by the Northeastern Forest Experiment Station, Forest Service, U.S.D.A. The idea for this study originated at the Northeastern Forest Experiment Station. It has partially supported two graduate students, one of whom was the junior author, Richard D. Hopkins, Resource Economics. The other was Arthur Bradbury of Forest Resources who developed the initial compilations on white pine plantations.

Estimated Financial Returns from Two White Pine Plantations

Oliver P. Wallace, Sr.
Richard D. Hopkins*

Eastern white pine is found on land with many different soil and moisture conditions (8) even including such extremes as dry rocky ridges and wet sphagnum bogs. Best development, however, is made on moist sandy loam soils or those with a small proportion of clay. White pine poses no special difficulties to establishment on open land. If given a seed supply, it will usually restock sparsely vegetated areas by natural seeding. In the Northeast region the exodus from farm land has frequently been followed by natural restocking of the abandoned land by white pine. State forest nurseries in the Northeast are producing millions of white pine seedlings annually. Many of these seedlings are being planted under all sorts of environmental conditions with little evaluation of the economics involved. Despite years of research, little concrete information is available as to what a plantation on a specific growing site will yield in terms of physical volume, given the stand stocking and a thinning schedule. The long time period required to bring a stand to maturity and changes in personnel, ownership and management, measurement methods and tools, and markets all combine to frustrate a clear cut reporting of what a white pine plantation will yield.

Several factors now present, i.e., rapidly rising land prices, declining markets for boards, and the near extinction of the box board market make knowledge of investment opportunities highly desirable. There is also a change in the type of people purchasing forest land; their motives for land ownership are based on recreation and aesthetic values. The activity of these people has contributed to higher land prices.

The return to be expected from white pine plantations is of interest to investors and forest managers in the Northeast, throughout the Appalachian range, in sections of the lake state, and in bordering areas of Canada. Private investors are interested in rating white pine plantation establishments as compared to other investment opportunities.

Recently published techniques (9) coupled with serious efforts to determine volume yields now allow preliminary calculations of white pine investment opportunities. This report presents rates of return earned by the establishment and maintenance of two selected white pine plantations under a given set of assumptions. The methods used in this analysis may assist investors in analyzing the investment opportunities available to them when establishing plantations. Estimating future potential returns is difficult because financial yields are sensitive to tree

* Associate Professor of Forest Resources and graduate student, Department of Resource Economics, respectively.

growth, product prices, and market behavior. Tree growth and management practices differ according to differences in site and to lengths of growing seasons. Product prices fluctuate according to market conditions. Acknowledging the elusive nature of these variables, the financial decision to plant white pine must be based upon the expectations of good volume growth, favorable prices, and an adequate market.

According to Lane (10) low thinning has been the most widely practiced method of thinning in white pine stands. Examples of the low thinning method for periods exceeding 30 years included the Saginaw Forest in southeastern Michigan (16), the Biltmore Estate in western North Carolina (17), and the Yale Forest in southwestern New Hampshire (7). In these managed areas thinnings at 5 to 7 year intervals each removed about 10 to 20 percent of the stocking. In no instance was the total growth increased. However, the amount of usable wood was 12 to 35 percent more where thinning has been applied. Smithers (15) thinned at 5-year intervals from age 30 to 50, removing about 15 percent of the basal area with each thinning. Thereafter thinning removed about 10 percent of the basal area every 10-year interval.

This white pine investment study is based upon data derived from reports of the Yale white pine stands near Keene, New Hampshire, which have a site index of 60 (6, 7), and a white pine plantation at the Biltmore Forest in North Carolina which has a site index of 65 (17). These data cover a time period of sufficient duration to obtain significant information on physical yield of white pine. A basal area control of 100 square feet/acre maintained by thinning at regular intervals was the management practice used on the plantations studied.

The first section of the report explains the physical yield for thinning and harvests on both the site index 60 stand and the site index 65 stand. The second section show the projection and calculation of prices for harvest and thinning cuts for sawlogs and pulpwood. The third section explains the assumptions about establishment costs, carrying charges, and harvest and thinning costs. The fourth section includes the calculation of financial returns. Financial returns are calculated on rotations of varying lengths (45, 55, 65, 70, and 75 years) from a base year of 1967. Thus a 55-year rotation would be harvested in the year 2022. The format of this report follows that used by Manthy et. al. (12) for red pine plantations.

Physical Yields

Physical yields used for the site index 60 stand are given in Table 1. The stand was thinned periodically to a basal area of 100 square feet per acre. Table 2 gives yields for the site index 65 stand, thinned periodically to a basal area of 100 square feet.

The data from the Yale forest (site index 60) included only three thinnings from age 35 through age 55. Therefore, it was necessary to project this information forward to age 70 using formulae developed by Barrett.* The data from the Biltmore plantation (site index 65) in-

* Barrett, J. P. Associate Professor of Forest Resources. University of New Hampshire. Data unpublished.

Table 1. White Pine — Per Acre Yields*, Site Index 60. Thinned to Basal Area of 100 Square Feet

Age	Thinnings		Harvest	
	Sawlogs MBF	Pole Trees and tops Cords	Sawlogs MBF	Pole Trees and tops Cords
35		6.5		
45	2.0	5.6	8.0	14.7
55	2.8	6.8	15.9	10.2
65	11.1†	7.0†	27.2†	3.7†
70			18.3†	

* Developed from Hawley, R. C. 1927. Pure white pine stands. Yale School of Forestry Bull. No. 20 — using formulae developed by James P. Barrett.
† Projected data.

cludes thinnings from age 20 through age 55. It was again necessary to project data in this case to rotation ages 65 and 75.

Sawlog Pricing

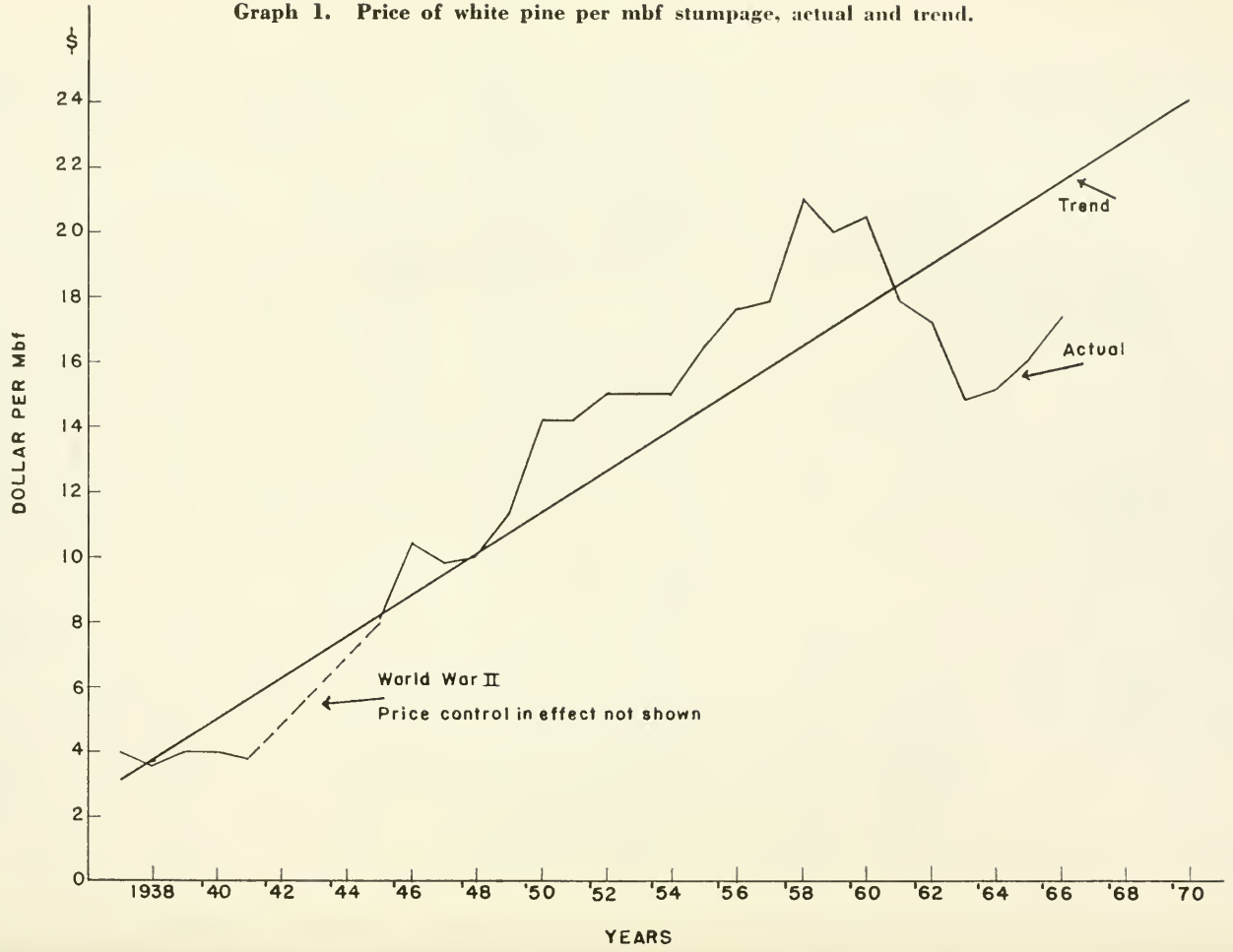
In considering the usefulness of price projections, the relation of one price schedule to another price schedule (sawlogs prices vs. pulpwood prices and harvest cut prices vs. thinning cut prices) is more important than the absolute values of any and all price schedules. To date sawlog prices have been higher than pulpwood prices for equal volumes (5) and harvest prices have been higher than thinning prices for equal volumes. These relations hold in the current year and are expected to hold in future years, therefore such price relations are an assumption of this analysis. Costs are related to returns in a somewhat similar man-

Table 2. White Pine — Per Acre Yields*, Site Index 65, Thinned to Basal Area of 100 Square Feet

Age	Thinnings		Harvest	
	Sawlogs MBF	Pole Trees and tops Cords	Sawlogs MBF	Pole Trees and tops Cords
20		4.3		
25		12.0		
30	0.296	5.2		
40		4.2		
45	0.656	10.4	17.2	8.0
55	0.844	9.7	16.94	13.3
65	8.600†	5.2†	27.10†	8.0†
75			22.80†	8.6†

* Developed from Wahlenberg, W. J. 1955. Six thinnings on a 56 year old pure white pine plantation of Biltmore. Jour. of For. Vol. 53, No. 5 — using formulae developed by James P. Barrett.
† Projected data.

Graph 1. Price of white pine per mbf stumpage, actual and trend.



ner in both the current and in future years. The absolute values of prices and costs do increase but the various price schedules maintain a similar relationship throughout the price projections. This relationship between price schedules is an important assumption of the financial analysis in this study. As a result of this relationship, the projected price schedules resulted in findings that are very similar to those that would result from the use of the current year price schedule. However, if the market demand or the technical processes change, a major alteration in the market structure would occur and thus the relationship between price schedules would change. If such an alteration in the market structure occurs, then a review of the whole situation will be necessary.

The projected price levels for harvest cuts were obtained by a linear regression analysis of white pine sawlog harvest prices for the past 30 years. These prices are shown in Table 3. They are quoted from the sales experiences of county foresters and published in annual market reports (5). War price controls were in effect during the years 1942, 1943, and 1944. Therefore, to obtain prices for these years, a straight line trend was assumed between the years 1941 and 1945. The 1942, 1943, and 1944 prices were taken at the appropriate intervals along this trend line. The resulting trend is shown in Graph 1. The slope is shown to be 0.579 and the Y-intercept at the initial year, 1937, was 3.40. To obtain the stumpage price "X years" from the initial year, multiply the "X years" by .579 and add 3.40. This yields the stumpage price "X years" from the initial year, i.e., in 1997 the theoretical harvest price will be (60) (.579) + 3.4 or $38.14.

The price index of white pine stumpage in New Hampshire (13) has risen faster than the wholesale price index of all lumber. However, since 1955 the stumpage price index shows a greater fluctuation and

Table 3. History of White Pine Sawlog Prices

Year	Average Price	Year	Average Price
1937	4.00	1952	15.00
1938	3.75	1953	15.00
1939	4.00	1954	15.00
1940	4.00	1955	16.30
1941	3.90	1956	17.50
*1942	4.93	1957	17.80
*1943	5.95	1958	21.00
*1944	6.98	1959	20.00
1945	8.00	1960	20.50
1946	10.25	1961	17.70
1947	9.75	1962	17.10
1948	10.00	1963	14.80
1949	11.25	1964	15.30
1950	14.15	1965	16.00
1951	14.15	1966	17.50

* War price controls were in effect during these years. The prices shown are taken from a straight line trend between the prices of 1941 and 1945.

Source: Forest Market Reports. Cooperative Extension Service, UNH, Durham, New Hampshire.

Graph 2. Price index comparisons.

literally no trend through 1967 (Graph 2). The expectation is that stumpage prices will rise at a rate no less than that of other major indexes.

Prices reflect size differences as well as time differences. The price for trees on a 55-year rotation (55 years from 1967) will be lower than the price for trees on a 70-year rotation (70 years from 1967). This is the result of the increase in prices over time and the increase in tree size which adds to the value of the sawlog (5).

In any given year sawlogs may be cut either as a harvest operation or as a thinning operation. Sawlogs cut for thinning purposes will be smaller and of lesser quality and come from trees of lesser diameter and height than sawlogs cut as a harvest. The trees untouched during thinning operations are potential harvest trees, chosen for their greater diameter and height growth. Therefore, a harvest cut will return a higher price per M.b.f. than will a thinning cut. Thus, sawlog prices for thinning and for harvest operations in a given year should reflect the size differential — prices for thinning operation sawlogs being lower than prices for harvest cut sawlogs. Therefore, a second schedule of prices was developed to reflect the size differential between trees in harvest and thinning cuts. The prices for sawlogs cut under a thinning operation were projected on the same trend as the harvest prices. By using the calculated 1966 sawlog price for thinning operations of $9.42 and adding (.579) (X years) in 31 years, the price would equal $9.42 + (.579) (31) = $27.37 per M.b.f. for the year 1997.

Pulpwood Pricing

The stumpage price of pulpwood is assumed to increase in the future at the compound rate of 2.25 percent a year. The price for 1966 was taken at $1.96 (5). Thus in 21 years, or 1987, the price would be $3.12. After 66 years, or the year 2032, the price of pulp was frozen at the 66th year level, or $8.49. The schedule of pulp prices is shown in Table 4.

Analysis of stands for pulpwood production only is not included since such stands would not require thinning schedules nor long ro-

Table 4. Projected Pulpwood Prices for White Pine

Years from 1966	Price per Cord
21	3.12
26	3.49
31	3.90
36	4.36
41	4.87
46	5.44
56	6.80
66	8.49
76	8.49

tations. Also no data on pulpwood volume yields of white pine stands managed only for pulpwood are available.

Costs

Establishment Cost: An establishment cost of $35.00 per acre was used (12). This includes site preparation, planting stock, and the planting operation. In general it includes all cost associated with the initiation of the plantation.

Annuity: An annual carrying charge is levied to cover the annual costs of taxes, fire protection, and general management expenses. A single valued annuity is used. This annuity is influenced by the length of rotation; as the length of rotation increases, the annuity increases. The annuity is determined from a base value of $1.00 per year increased at the rate of 15 percent decade. However, a single value is used for the annuity — that value which is calculated to the year of harvest, i.e., in 65 years the annuity is $2.31 as shown in Table 5. Thus the annual carrying charge on a 65-year rotation is $2.31. A single value is used as the annuity for simplicity of calculation. A single value also increases the actual amount paid over the basic variable annuity of $1.00 increased at 15 percent per decade. The actual amount paid for the single valued annuity increases the outlay by approximately $50.00 in 65 years.

Thinning and Harvest Costs: The expenses associated with each thinning operation are assumed to be 12 percent of the dollar value of the sawlogs and pulpwood cut during the thinning. The expenses associated with each harvest operation are assumed to be ten percent of the dollar value of the sawlogs and pulpwood harvested. These percentages are based on current charges consulting foresters in New Hampshire.

Determination of Financial Yield

To compute the financial return for various rotation ages, given the previous data on physical volumes, prices, and costs, the only further requirement is a table showing the present value of $1.00 at

Table 5. Annual Carrying Costs with Initial Base of $1.00 Increased 15 Percent per Decade

Years	Carrying Costs
0-10	1.00
10-20	1.15
20-30	1.32
30-40	1.52
40-50	1.75
50-60	2.01
60-70	2.31
70-80	2.65

various rates of interest and a table showing the present value of $1.00 per annum at compound interest. Table 6 (a to h) * gives the expected future costs and returns for each site and rotation period.

A land expectation value is not necessarily related to actual prices. It reflects the value that may be assigned to land for a given investment and management program. Interest rates are usually assumed.

The land expectation value is then calculated in the following manner: All expected future returns are discounted and all expected future costs (annuities) are also discounted to give present values. The discounted cost value subtracted from the discounted return value yields the land expectation value at specific rates of interest, i.e., as shown in Table 7 (a to h).*

Financial Return

Graphs 3 and 4 show land expectation values at varying rates of interest and rotation ages for site indexes 60 and 65 for the stands studied. They show the investor the value he could assign to the land which would yield the specified rate of return. This value can be used as a guide for the purchase of land for white pine plantation establishment under the given level of management. The maximum rate of return for each rotation occurs at a zero land value.

If land is already owned and will continue to be owned, then rates of interest more clearly reflect investment opportunities represented by the choices of plantation establishment and management levels for a particular tract of land.

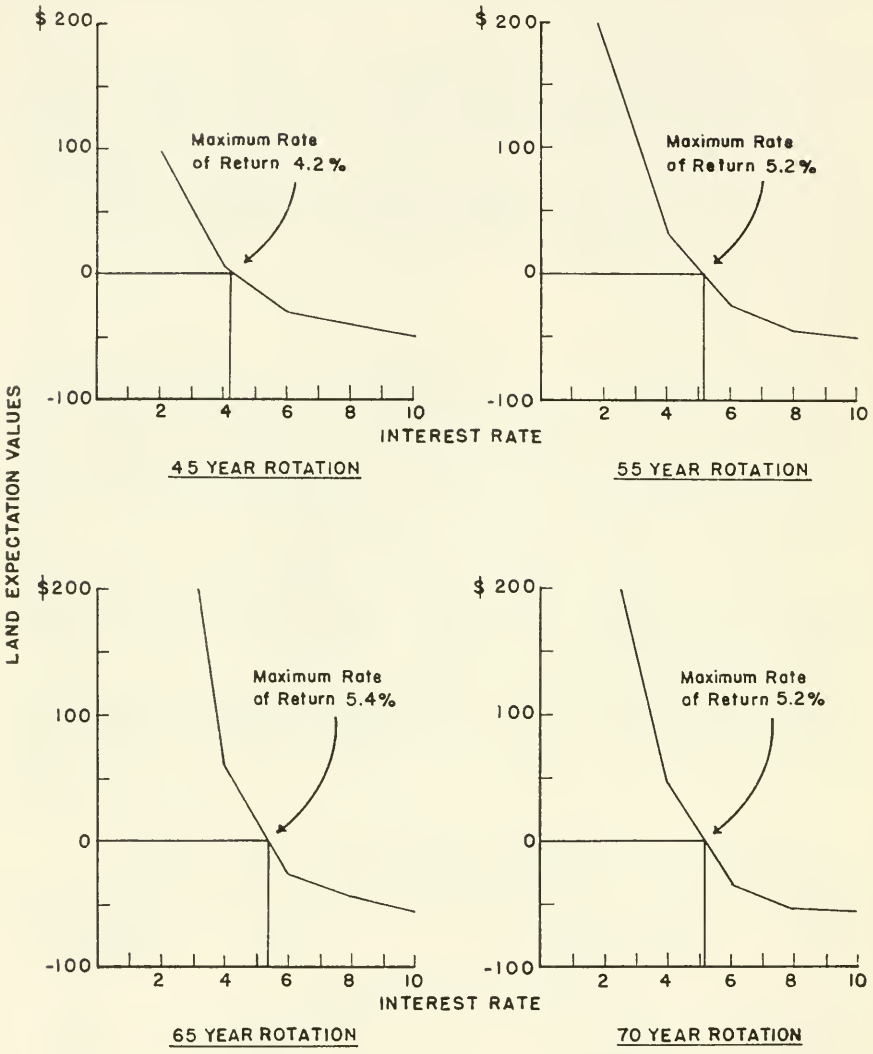
A comparison of the two stands when land cost is zero, Table 9, shows that the stand on site index 65 yielded a higher rate of return than the stand on site index 60 for similar rotation ages. The stand on site index 60 had its highest rate of return, 5.4 percent, at a rotation age of 65 years. The rate of return decreased for both shorter and longer rotations. However, since the rates of return for rotations of 55, 65 and 60 years are very close, it would be advisable to say that the maximum rate of return could easily fall in any of the three rotations.

Table 9. Maximum Rate of Return on Plantations Studied, Cost of Land = Zero

Rotation Age	Maximum rate of return percent	Rotation Age	Maximum rate of return percent
45	4.2	45	6.7
55	5.2	55	5.8
65	5.4	65	5.7
70	5.0	75	5.4

* See Appendix for Tables 6 and 7.

Graph 3. Land expectation values, site index 60, thinned to basal area of 100 square feet per acre.

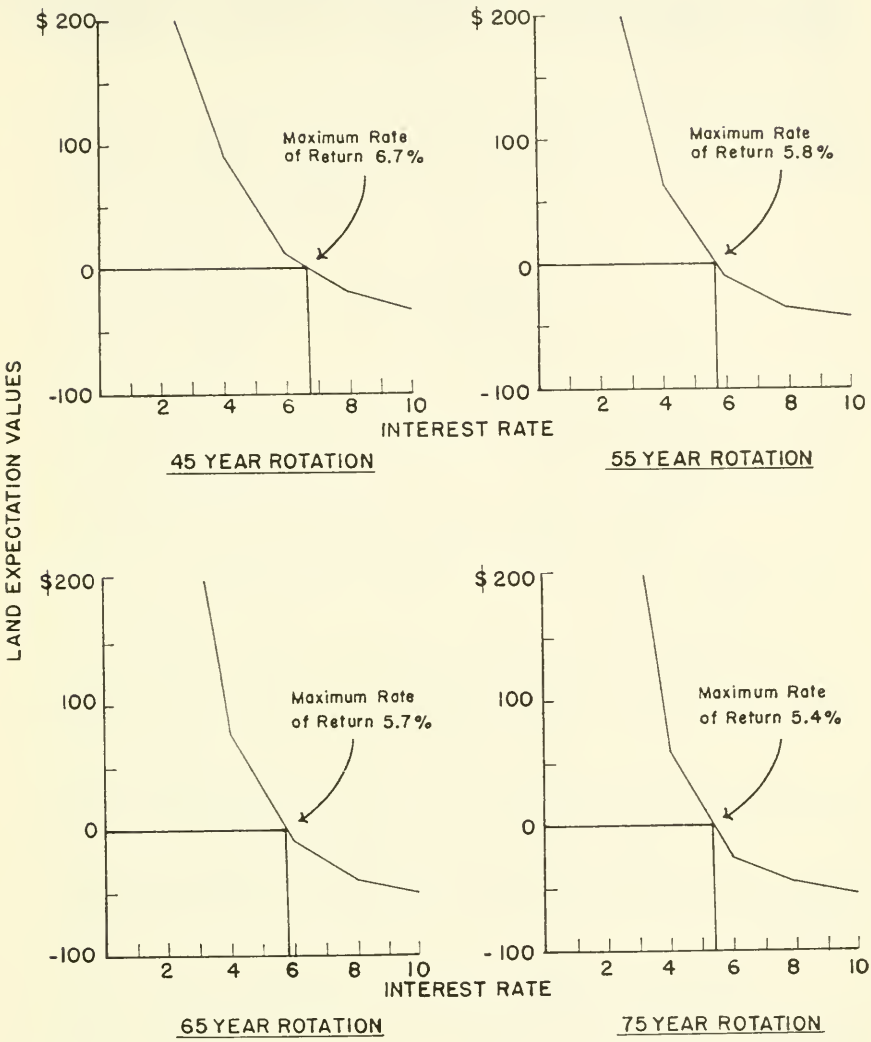


The stand on site index 65 showed a maximum rate of return of 6.7 percent at a rotation of 45 years. Longer rotations resulted in a decreasing rate of return. Because data were not available for shorter rotations it is not possible to determine whether a higher rate of return could be realized from a shorter rotation.

Conclusions

Land prices are escalating rapidly in the Northeast. Some factors which contribute are clearly non-forestry but once land is acquired

Graph 4. Land expectation values, site index 65, thinned to basal area of 100 square feet per acre.



many owners want to plant trees. By analyzing their plantation opportunity as determined here, they have a basis for comparison with alternative uses of their land. The analysis also indicates that shorter rotations should be used on better sites to maximize rates of return.

If a risk factor of 2-4 percent is included in any interest rate to be used as minimal criteria for investment, then site 60 is likely to be considered as marginal or sub-marginal for white pine plantations. The site 60 rotation of 65 years for the maximum rate of return is 20 years longer than that for site 65 and the rate is 1.3 percentage points lower. Site 70 would undoubtedly give a higher rate of return. Yoho

and Fosick report that "the rate of return from good sites is approximately double that from poor sites for uniform investment levels and rotation lengths". This is for Loblolly and slash pine plantations in the South.* They also found that shorter rotations were possible on good sites as compared to poor sites.

* Yoho and Fosick. 1965. A guide to loblolly and slash pine plantation management in southeastern U.S.A. Georgia Forest Research Council.

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APPENDIX

Table 6a. Net Expected Future Yields per Acre for a White Pine Plantation, Site Index 60, 70-Year Rotation, Thinned to Basal Area of 100 Square Feet per Acre.

		Sawlogs					Pulpwood				
				Expected Future Returns	Expected Future Costs				Expected Future Returns	Expected Future Costs	
Stand Age (years)	Operation*	Yield	Price per Mbf	Dollar Value	Thinning and Harvest cost†	Net Expected Yields	Yield (cords)	Price per cord	Dollar Value	T & H costs†	Net Expected Yields
		Mbf									
35	T						6.5	$4.36	$28.34	$3.40	$24.94
45	T	2.0	$36.06	$ 72.12	$ 8.65	$ 63.47	5.6	5.44	30.46	3.66	26.80
55	T	2.8	41.84	117.15	14.06	103.09	6.8	6.80	46.24	5.55	40.69
65	T	11.1	47.64	528.80	63.46	465.34	7.0	8.49	59.43	7.13	52.30
70	H	18.3	61.31	1121.97	112.20	1009.77	.....	.....	.....	.....	

* T — Thinning; H — Harvest.
† Thinning costs equal 12 % of dollar value; Harvest costs equal 10% of dollar value.

Table 6b. Net Expected Future Yields per Acre for a White Pine Plantation, Site Index 60, 65-Year Rotation, Thinned to Basal Area of 100 Square Feet per Acre.

			Sawlogs						Pulpwood		
				Expected Future					Expected Future		
				Returns	Costs				Returns	Costs	
Stand Age (years)	Operation*	Yield	Price per Mbf	Dollar Value	Thinning and Harvest cost†	Net Expected Yields	Yield (cords)	Price per cord	Dollar Value	T & H costs†	Net Expected Yields
		Mbf									
35	T						6.5	$4.36	$28.34	$3.40	$24.94
45	T	2.0	$36.06	$ 72.12	$ 8.65	$ 63.47	5.6	5.44	30.46	3.66	26.80
55	T	2.8	41.84	117.15	14.06	103.09	6.8	6.80	46.24	5.55	40.69
65	H	27.2	58.40	1588.48	158.85	1429.63	3.7	8.49	31.41	3.14	28.27

* T — Thinning; H — Harvest.

† Thinning costs equal 12% of dollar value; Harvest costs equal 10% of dollar value.

Table 6c. Net Expected Future Yields per Acre for a White Pine Plantation, Site Index 60, 55-Year Rotation, Thinned to Basal Area of 100 Square Feet per Acre.

			Sawlogs				Pulpwood				
				Expected Future Returns	Costs				Expected Future Returns	Costs	
Stand Age (years)	Operation*	Yield	Price per Mbf	Dollar Value	Thinning and Harvest cost†	Net Expected Yields	Yield (cords)	Price per cord	Dollar Value	T & H costs†	Net Expected Yields
		Mbf									
35	T						6.5	$4.36	$28.34	$3.40	$24.94
45	T	2.0	$36.06	$ 72.12	$ 8.65	$ 63.47	5.6	5.44	30.46	3.66	26.80
55	H	15.9	52.61	836.50	83.65	752.85	10.2	6.80	69.36	6.94	62.42

* T — Thinning; H — Harvest.
† Thinning costs equal 12% of dollar value; Harvest costs equal 10% of dollar value.

Table 6d. Net Expected Future Yields per Acre for a White Pine Plantation, Site Index 60, 45-Year Rotation, Thinned to Basal Area of 100 Square Feet per Acre.

			Sawlogs				Pulpwood				
				Expected Future Returns	Costs				Expected Future Returns	Costs	
Stand Age (years)	Operation*	Yield	Price per Mbf	Dollar Value	Thinning and Harvest cost†	Net Expected Yields	Yield (cords)	Price per cord	Dollar Value	T & H costs†	Net Expected Yields
		Mbf									
35	T						6.5	$4.36	$28.34	$3.40	$24.94
45	H	8.0	$46.82	$374.56	$37.46	$337.10	14.7	5.44	79.97	8.00	71.97

* T — Thinning; H — Harvest.
† Thinning costs equal 12% of dollar value; Harvest costs equal 10% of dollar value.

Table 6c. Net Expected Future Yields per Acre for a White Pine Plantation, Site Index 65, 75-Year Rotation, Thinned to Basal Area of 100 Square Feet per Acre.

		Sawlogs					Pulpwood				
				Expected Future Returns	Costs				Expected Future Returns	Costs	
Stand Age (years)	Operation*	Yield	Price per Mbf	Dollar Value	Thinning and Harvest cost†	Net Expected Yields	Yield (cords)	Price per cord	Dollar Value	T & H costs†	Net Expected Yields
		Mbf									
20	T						4.3	$3.12	$13.41	$1.61	$11.80
25	T						12.0	3.49	41.88	5.02	36.86
30	T	.296	$27.37	$ 8.10	$ .97	$ 7.13	5.2	3.90	20.28	2.43	17.85
40	T						4.2	4.87	20.45	2.45	18.00
45	T	.656	36.06	23.66	2.84	20.82	10.4	5.44	56.57	6.79	49.78
55	T	.844	41.84	35.31	4.24	31.07	9.7	6.80	65.96	7.92	58.04
65	T	8.60	47.64	409.70	49.16	360.54	5.2	8.49	44.14	5.30	38.84
75	H	22.8	64.19	1463.53	146.35	1317.18	8.6	8.49	73.01	7.30	65.71

* T — Thinning; H — Harvest.
† Thinning costs equal 12% of dollar value; Harvest costs equal 10% of dollar value.

Table 6f. Net Expected Future Yields per Acre for a White Pine Plantation, Site Index 65, 65-Year Rotation, Thinned to Basal Area of 100 Square Feet per Acre.

		Sawlogs					Pulpwood				
				Expected Future					Expected Future		
Stand Age (years)	Operation*	Yield	Price per Mbf	Returns Dollar Value	Costs Thinning and Harvest cost†	Net Expected Yields	Yield (cords)	Price per cord	Returns Dollar Value	Costs T & H costs†	Net Expected Yields
		Mbf									
20	T						4.3	$3.12	$13.41	$1.61	$11.80
25	T						12.0	3.49	41.88	5.02	36.86
30	T	.296	$27.37	$ 8.10	$ .97	$ 7.13	5.2	3.90	20.28	2.43	17.85
40	T						4.2	4.87	20.45	2.45	18.00
45	T	.656	36.06	23.66	2.84	20.82	10.4	5.44	56.57	6.99	49.78
55	T	.844	41.84	35.31	4.24	31.07	9.7	6.80	65.96	7.92	58.04
65	H	27.10	58.40	1582.64	158.26	1424.38	8.0	8.49	67.92	6.79	61.13

* T — Thinning; H — Harvest.
† Thinning costs equal 12% of dollar value; Harvest costs equal 10% of dollar value.

Table 6g. Net Expected Future Yields per Acre for a White Pine Plantation, Site Index 65, 55-Year Rotation Thinned to Basal Area of 100 Square Feet per Acre.

		Sawlogs					Pulpwood				
				Expected Future					Expected Future		
				Returns	Costs				Returns	Costs	
Stand Age (years)	Operation*	Yield	Price per Mbf	Dollar Value	Thinning and Harvest cost†	Net Expected Yields	Yield (cords)	Price per cord	Dollar Value	T & H costs†	Net Expected Yields
		Mbf									
20	T						4.3	$3.12	$13.41	$1.61	$11.80
25	T						12.0	3.49	41.88	5.02	36.86
30	T	.296	$27.37	$ 8.10	$ .97	$ 7.13	5.2	3.90	20.28	2.43	17.85
40	T						4.2	4.87	20.45	2.45	18.00
45	T	.656	36.06	23.66	2.84	20.82	10.4	5.44	56.57	6.79	49.78
55	H	16.94	52.61	891.21	89.12	802.09	13.3	6.80	90.44	9.04	81.40

* T — Thinning; H — Harvest.
† Thinning costs equal 12% of dollar value; Harvest costs equal 10% of dollar value.

Table 6h. Net Expected Future Yields per Acre for a White Pine Plantation, Site Index 65, 45-Year Rotation, Thinned to Basal Area of 100 Square Feet per Acre.

		Sawlogs					Pulpwood				
				Expected Future Returns	Costs				Expected Future Returns	Costs	
Stand Age (years)	Operation*	Yield	Price per Mbf	Dollar Value	Thinning and Harvest cost†	Net Expected Yields	Yield (cords)	Price per cord	Dollar Value	T & H costs†	Net Expected Yields
		Mbf									
20	T						4.3	$3.12	$13.41	$1.61	$11.80
25	T						12.0	3.49	41.88	5.02	36.86
30	T	.296	$27.37	$ 8.10	$ .97	$ 7.13	5.2	3.90	20.28	2.43	17.85
40	T	.....					4.2	4.87	20.45	2.45	18.00
45	H	17.2	46.82	805.30	80.53	724.77	8.0	5.44	43.52	4.35	39.17

* T — Thinning; H — Harvest.
† Thinning costs equal 12% of dollar value; Harvest costs equal 10% of dollar value.

Table 7a. Financial Return of a White Pine Plantation, Site Index 60, 70-Year Rotation, Thinned to Basal Area of 100 Square Feet per Acre.

Per Acre

Operation and year*	Net Expected Future yields and expenses	Present values of returns and expenses at specified interest rates				
		2%	4%	6%	8%	10%
HS_{70}	1009.77	252.46	64.84	17.08	4.61	1.27
TS_{65}	465.34	128.46	36.36	10.54	3.13	0.94
T_{65}	52.30	14.44	4.09	1.18	0.35	0.11
TS_{55}	103.09	34.69	11.92	4.18	1.50	0.54
T_{55}	40.69	13.69	4.70	1.65	0.59	0.21
TS_{45}	63.47	26.03	10.86	4.61	1.99	0.87
T_{45}	26.80	10.99	4.59	1.95	0.84	0.37
T_{35}	24.94	12.47	6.32	3.24	1.69	0.89
X		493.23	143.68	44.43	14.70	5.20
C	35.00	35.00	35.00	35.00	35.00	35.00
e	2.65	99.37	61.97	43.42	32.97	26.47
Y		134.37	96.99	78.42	67.97	61.47
Se=X–Y		358.86	46.69	–33.99	–53.27	–56.27

T = thinning; H = harvest; X = total present value at various interest rates; C = constant establishment cost; e = present value of annuity at various interest rates; Y = C + e.

Table 7b. Financial Return of a White Pine Plantation, Site Index 60, 65-Year Rotation, Thinned to Basal Area of 100 Square Feet per Acre.

Per Acre

Operation and year*	Net Expected Future yields and expenses	Present values of returns and expenses at specified interest rates				
		2%	4%	6%	8%	10%
HS_{65}	1429.63	394.65	111.70	32.38	9.61	2.90
H_{65}	28.27	7.80	2.21	0.64	0.19	0.06
TS_{55}	103.09	34.69	11.92	4.18	1.50	0.54
T_{55}	40.69	13.69	4.70	1.65	0.59	0.21
TS_{45}	63.47	26.03	10.86	4.61	1.99	0.87
T_{45}	26.80	10.99	4.59	1.95	0.84	0.37
T_{35}	24.94	12.47	6.32	3.24	1.69	0.89
X		500.32	152.30	48.65	16.41	5.84
C	35.00	35.00	35.00	35.00	35.00	35.00
e	2.31	86.62	54.04	37.85	28.74	23.07
Y		121.62	89.04	72.85	63.74	58.07
Se=X–Y		378.70	63.26	–24.20	–47.33	–52.23

T = thinning; H = harvest; X = total present value at various interest rates; C = constant establishment cost; e = present value of annuity at various interest rates; Y = C + e.

* superscript: s represents sawlogs; no superscript represents pulpwood; subscript represents year of operation in rotation period.

Table 7c. Financial Return of a White Pine Plantation, Site Index 60, 55-Year Rotation, Thinned to Basal Area of 100 Square Feet per Acre.

Operation and year*	Net Expected Future yields and expenses	Per Acre: Present values of returns and expenses at specified interest rates				
		2%	4%	6%	8%	10%
HS_{55}	752.85	253.33	87.07	30.54	10.92	3.98
H_{55}	62.42	21.00	7.22	2.53	0.90	0.33
TS_{45}	63.47	26.03	10.86	4.61	1.99	0.87
T_{45}	26.80	10.99	4.59	1.95	0.84	0.37
T_{35}	24.94	12.47	6.32	3.24	1.69	0.89
X		323.82	116.06	42.87	16.34	6.44
C	35.00	35.00	35.00	35.00	35.00	35.00
e	2.01	66.68	44.44	32.14	24.76	19.99
Y		101.68	79.44	67.14	59.76	54.99
Se=X–Y		222.14	36.62	–24.27	–43.42	–48.55

T = thinning; H = harvest; X = total present value at various interest rates; C = constant establishment cost; e = present value of annuity at various interest rates; Y = C + e.

Table 7d. Financial Return of a White Pine Plantation, Site Index 60, 45-Year Rotation, Thinned to Basal Area of 100 Square Feet per Acre.

Operation and year*	Net Expected Future yields and expenses	Per Acre: Present values of returns and expenses at specified interest rates				
		2%	4%	6%	8%	10%
HS_{45}	337.10	138.28	57.71	24.49	10.56	4.62
H_{45}	71.97	29.52	12.32	5.23	2.25	0.99
T_{35}	24.94	12.47	6.32	3.24	1.69	0.89
X		180.27	76.35	32.96	14.50	6.50
C	35.00	35.00	35.00	35.00	35.00	35.00
e	1.75	51.61	36.26	27.05	21.19	17.26
Y		86.61	71.26	62.05	56.19	52.26
Se=X–Y		93.66	5.09	–29.09	–41.69	–45.76

T = thinning; H = harvest; X = total present value at various interest rates; C = constant establishment cost; e = present value of annuity at various interest rates; Y = C + e.

* superscript: s represents sawlogs; no superscript represents pulpwood; subscript represents year of operation in rotation period.

Table 7e. Financial Return of a White Pine Plantation, Site Index 65, 75-Year Rotation, Thinned to Basal Area of 100 Square Feet per Acre.

Operation and year*	Net Expected Future yields and expenses	Per Acre: Present values of returns and expenses at specified interest rates				
		2%	4%	6%	8%	10%
HS_{75}	1317.18	298.28	69.52	16.65	4.10	1.03
H_{75}	65.71	14.88	3.47	0.83	0.20	0.05
TS_{65}	360.54	99.53	28.17	8.17	2.42	0.73
T_{65}	38.84	10.72	3.03	0.88	0.26	0.08
TS_{55}	31.07	10.46	3.59	1.26	0.45	0.16
T_{55}	58.04	19.53	6.71	2.35	0.84	0.31
TS_{45}	20.82	8.54	3.56	1.51	0.65	0.28
T_{45}	49.78	20.42	8.52	3.62	1.56	0.68
T_{40}	18.00	8.15	3.75	1.75	0.83	0.40
TS_{30}	7.13	3.94	2.20	1.24	0.71	0.41
T_{30}	17.85	9.85	5.50	3.11	1.77	1.02
T_{25}	36.86	22.47	13.83	8.59	5.38	3.40
T_{20}	11.80	7.94	5.38	3.68	2.53	1.75
X		534.71	157.23	53.64	21.70	10.30
C	35.00	35.00	35.00	35.00	35.00	35.00
e	2.65	102.49	62.75	43.61	33.02	26.48
Y		137.49	97.75	78.61	68.02	61.48
Se=X–Y		397.22	59.48	–24.97	–46.32	–51.18

T = thinning; H = harvest; X = total present value at various interest rates; C = constant establishment cost; e = present value of annuity at various interest rates; Y = C + e.

Table 7f. Financial Return of a White Pine Plantation, Site Index 65, 65-Year Rotation, Thinned to Basal Area of 100 Square Feet per Acre.

Operation and year*	Net Expected Future yields and expenses	Per Acre: Present values of returns and expenses at specified interest rates				
		2%	4%	6%	8%	10%
HS_{65}	1424.38	393.20	111.29	32.26	9.57	2.89
H_{65}	61.13	16.87	4.78	1.38	0.41	0.12
TS_{55}	31.07	10.46	3.59	1.26	0.45	0.16
T_{55}	58.04	19.53	6.71	2.35	0.84	0.31
TS_{45}	20.82	8.54	3.56	1.51	0.65	0.28
T_{45}	49.78	20.42	8.52	3.62	1.56	0.68
T_{40}	18.00	8.15	3.75	1.75	0.83	0.40
TS_{30}	7.13	3.94	2.20	1.24	0.71	0.41
T_{30}	17.85	9.85	5.50	3.11	1.77	1.02
T_{25}	36.86	22.47	13.83	8.59	5.38	3.40
T_{20}	11.80	7.94	5.38	3.68	2.53	1.75
X		521.37	169.11	60.75	24.70	11.42
C	35.00	35.00	35.00	35.00	35.00	35.00
e	2.31	83.62	53.24	37.63	28.68	23.05
Y		118.62	88.24	72.63	63.68	58.05
Se=X–Y		402.75	80.87	–11.88	–38.98	–46.63

T = thinning; H = harvest; X = total present value at various interest rates; C = constant establishment cost; e = present value of annuity at various interest rates; Y = C + e.

* superscript: s represents sawlogs; no superscript represents pulpwood; subscript represents year of operation in rotation period.

Table 7g. Financial Return of a White Pine Plantation, Site Index 65, 55-Year Rotation, Thinned to Basal Area of 100 Square Feet per Acre.

Operation and year*	Net Expected Future yields and expenses	Per Acre: Present values of returns and expenses at specified interest rates				
		2%	4%	6%	8%	10%
HS_{55}	802.09	269.90	92.76	32.53	11.64	4.24
H_{55}	81.40	27.39	9.41	3.30	1.18	0.43
TS_{45}	20.82	8.54	3.56	1.51	0.65	0.28
T_{45}	49.78	20.42	8.52	3.62	1.56	0.68
T_{40}	18.00	8.15	3.75	1.75	0.83	0.40
TS_{30}	7.13	3.94	2.20	1.24	0.71	0.41
T_{30}	17.85	9.85	5.50	3.11	1.77	1.02
T_{25}	36.86	22.47	13.83	8.59	5.38	3.40
T_{20}	11.80	7.94	5.38	3.68	2.53	1.75
X		378.60	144.91	59.33	26.25	12.61
C	35.00	35.00	35.00	35.00	35.00	35.00
e	2.01	66.68	44.44	32.14	24.76	19.99
Y		101.68	79.44	67.14	59.76	54.99
Se=X–Y		276.92	65.47	–7.81	–33.51	–42.38

T = thinning; H = harvest; X = total present value at various interest rates; C = constant establishment cost; e = present value of annuity at various interest rates; Y = C + e.

Table 7h. Financial Return of a White Pine Plantation, Site Index 65, 45-Year Rotation, Thinned to Basal Area of 100 Square Feet per Acre.

Operation and year*	Net Expected Future yields and expenses	Per Acre: Present values of returns and expenses at specified interest rates				
		2%	4%	6%	8%	10%
HS_{45}	724.77	297.29	124.07	52.65	22.70	9.94
H_{45}	39.17	16.07	6.70	2.84	1.23	0.54
T_{40}	18.00	8.15	3.75	1.75	0.83	0.40
TS_{30}	7.13	3.94	2.20	1.24	0.71	0.41
T_{30}	17.85	9.85	5.50	3.11	1.77	1.02
T_{25}	36.86	22.47	13.83	8.59	5.38	3.40
T_{20}	11.80	7.94	5.38	3.68	2.53	1.75
X		365.71	161.43	73.86	35.15	17.46
C	35.00	35.00	35.00	35.00	35.00	35.00
e	1.75	51.61	36.26	27.05	21.19	17.26
Y		86.61	71.26	62.05	56.19	62.26
Se=X–Y		279.10	90.17	11.81	–21.04	–34.80

T = thinning; H = harvest; X = total present value at various interest rates; C = constant establishment cost; e = present value of annuity at various interest rates; Y = C + e.

* superscript: s represents sawlogs; no superscript represents pulpwood; subscript represents year of operation in rotation period.